Maritime Provinces, the Gulf of St. Lawrence, and Newfoundland. On the 30th, p. m., the storm center was in the Bay of Fundy, and pressure at Eastport, Me., was 28.78. On the 31st, a. m., the storm center was between Cape Breton and Newfoundland, and the pressure at Sidney was 28.88.

XXII.—On the 29th, a. m., low pressure was central near Vancouver Island; this extended rapidly inward as a slight and widely-diffused depression, and on the 30th, a. m., the lowest pressure was in Kansas and Colorado, and by the 30th, p. m., it had moved southward, stretching from New Mexico to Missouri, and by the 31st, a. m., still farther southward, extending from northern Texas to the lower Ohio Valley. By the 31st, p. m., this had become a trough reaching from southern Texas to West Virginia, dividing the regions of cold northerly and warm southerly winds; the steepest thermal gradients were a little to the north and parallel to the trough of lowest pressure.

XXIII.—This depression appeared in Alberta on the 31st, p. m.; its further history belongs to the REVIEW for February.

MOVEMENTS OF CENTERS OF AREAS OF HIGH AND LOW PRESSURE.

The following table shows the date and location of the beginning and ending of each center of high or low pressure that has appeared on the U. S. Weather Maps during the month, together with the average daily and hourly velocities for the month. These averages will differ accordingly as we consider each path as a distinct unit, or give equal weight to each hour of observation. The great variability in the rate of motion of these centers in different parts of the same path, or in different portions of the month, or over different portions of the regions covered by the Weather Map, points to the conclusion that the movement is largely influenced by general combinations of motions in the upper portion of the atmosphere, viz., above 5,000 or 10,000, but probably below 20,000 or 30,000 feet. The convection due to the heating and evaporation at the earth's surface does not easily permeate a still atmosphere to any great height, and we can not look to this convection in and of itself, as the exclusive cause or maintainer of extensive storms; on the other hand when the air is once in motion and by pushing over hills and mountains is forced up to considerable heights then the convection thus brought about will, if it intensifies the convection due to heat and moisture, produce conditions favorable to the formation of clouds and rain and the growth of any whirlwind, provided the whirling motion be, in the Northern Hemisphere, cyclonic, so as to be further favored by the action of the centrifugal forces on the revolving globe. If, however, the whirl be in the opposite direction, or if the conformation of the earth's surface be such as to oppose the convection due to heat (as, for instance, when the winds are descending a long slope instead of ascending) then the initial whirlwind is more likely to be annulled, or dissipated by the opposing forces. During the month of January quite a number of areas of high pressure and low pressure have alike been apparently annulled in this manner while comparatively few have been started under such favorable conditions as to allow of their growth and continued existence for several days. The apparent division of some of these high areas into several portions and the apparent perpetuity of high area No. VI*a* for ten days in the neighborhood of Utah are all undoubtedly due, in part, to the crudeness of the assumptions that underlie all methods of reducing plateau and mountain stations to sea level.

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.		°	°		°	°	*Miles.*	*Days.*	*Miles.*	*Miles.*
I	1, a. m.	29	99	3, p. m.	33	79	1,950	2.5	780	32
II	1, p. m.	54	112	4, a. m.	40	100	800	2.5	320	13
III	2, p. m.	51	124	3, p. m.	41	125	800	1.0	800	33
IV	4, a. m.	53	87	6, p. m.	48	66	1,150	2.5	460	19
V*a*	4, p. m.	52	115	8, a. m.	45	126	2,400	3.5	686	29
V*b*	4, p. m.	52	115	8, a. m.	32	105	2,100	3.5	600	25
VI	6, a. m.	59	104	7, a. m.	47	104	450	1.0	450	19
VI*a*	7, a. m.	47	104	21, a. m.	48	59	7,200	14.0	514	21
VI*b*	7, p. m.	47	104	11, a. m.	46	04	2,700	3.5	771	32
VI*c*	8, p. m.	49	104	9, a. m.	42	101	450	0.5	.....	.....
VI*d*	11, a. m.	39	111	13, a. m.	30	77	2,100	3.0	700	29
VII	15, a. m.	52	98	18, a. m.	44	63	1,950	3.0	650	27
VII*a*	18, p. m.	36	81	19, a. m.	33	83	200	0.5	.....	.....
VIII	17, p. m.	54	106	21, a. m.	47	59	2,250	3.5	643	27
IX	18, a. m.	54	117	19, p. m.	53	100	450	1.5	300	13
X	18, p. m.	39	125	20, p. m.	34	110	1,000	2.0	500	21
XI	20, p. m.	54	120	26, p. m.	46	58	4,000	6.0	667	28
XII	24, p. m.	55	107	28, p. m.	40	73	2,100	4.0	525	22
XIII	27, a. m.	42	109	31, p. m.	28	80	2,400	3.5	686	29
Sums	.....	.....	.....	.....	.....	.....	36,450	61.5	10,052	.....
Mean of 17 paths	.....	.....	.....	.....	.....	.....	.....	.....	591	24.6
Mean of 61.5 days	.....	.....	.....	.....	.....	.....	.....	.....	594	25.7
Low areas.										
I	1, a. m.	49	129	1, p. m.	47	120	400	0.5	.....	.....
II	1, a. m.	48	108	4, p. m.	48	64	2,750	3.5	786	33
III	1, p. m.	47	92	2, a. m.	47	86	250	0.5	.....	.....
IV	3, a. m.	54	114	3, p. m.	55	109	100	0.5	.....	.....
V	4, p. m.	36	115	6, p. m.	46	84	2,100	2.0	1,050	44
VI	5, a. m.	31	94	5, p. m.	34	95	250	0.5	.....	.....
VII	6, p. m.	38	75	8, a. m.	46	57	1,100	1.5	733	31
VIII	6, a. m.	28	98	7, a. m.	37	81	1,150	1.0	1,150	46
IX	6, a. m.	48	126	7, p. m.	45	118	450	1.5	300	12
X	8, p. m.	48	102	11, a. m.	35	78	1,550	2.5	620	26
XI	9, a. m.	52	113	13, a. m.	47	59	2,700	4.0	675	28
XII	11, a. m.	55	118	14, p. m.	55	91	1,600	3.5	457	19
XIII	14, a. m.	48	128	18, p. m.	51	66	3,700	4.5	822	34
XIV	15, p. m.	43	80	16, a. m.	41	69	600	0.5	.....	.....
XV	19, a. m.	37	103	22, a. m.	53	64	2,200	3.0	733	30
XVI	19, p. m.	55	125	20, a. m.	48	113	500	0.5	.....	.....
XVII	22, p. m.	32	114	23, p. m.	26	99	1,000	1.0	1,000	42
XVIII	24, a. m.	44	81	25, a. m.	51	60	1,050	1.0	1,050	42
XIX	26, a. m.	31	77	27, p. m.	45	60	1,400	1.5	933	39
XX	27, a. m.	53	118	29, p. m.	46	84	1,750	2.5	700	29
XXI	27, p. m.	26	97	31, a. m.	47	60	2,700	3.5	771	32
XXII	29, a. m.	49	126	31, p. m.	30	97	2,200	2.5	880	37
Sums	.....	.....	.....	.....	.....	.....	31,500	4.20	12,660	.....
Mean of 16 paths	.....	.....	.....	.....	.....	.....	.....	.....	791	33.0
Mean of 42.0 days	.....	.....	.....	.....	.....	.....	.....	.....	750	31.2

NORTH ATLANTIC METEOROLOGY.

[*Pressure in inches and millimeters; wind-force by Beaufort scale.*]

The normal pressure for January over the North Atlantic Ocean, as deduced from the international simultaneous observations, is highest, 30.20 (767), in a small area between the Azores and the Windward Islands; it is lowest, 29.50 (749), in a region between southern Greenland, Iceland, and Spitzbergen. As compared with December the normal pressure for January rises about 0.05 in the region southwest of the Azores, but falls in the extreme north Atlantic.

The average velocity of movement of storm centers during January is about 22 statute miles per hour, and at least two or three such storm centers can usually be traced across the ocean from Labrador and Nova Scotia to Norway and France, During January about an equal number of storm centers seem to reach the Atlantic near Newfoundland from British Columbia, the Gulf States, and the south Atlantic coast, respectively, but in general all of these are whirls developed within long troughs of low pressure whenever such troughs come into locations favorable for such development. All these troughs in January appear as the eastern ends of branches from either the north Pacific depression or the equatorial Pacific depression; the former stretches southeastward into Washington whenever a storm center moves northeastward toward southern

Alaska; the latter or Pacific equatorial stretches northward toward Mexico and the Caribbean Sea under circumstances not yet clearly understood, but when it does so the northerly winds over the United States descend to N. 20° and sometimes N. 15°, and give rise to the storms that pass from Florida northeastward toward Europe. Similarly, in July to September the Atlantic equatorial low stretches northwestward in connection with the development of West Indian hurricanes. An average of five storm paths per month passes eastward over the region between the Great Lakes and Newfoundland. After reaching W. 40° half of these pass northeast to Iceland, while the remainder go east or northeast toward central or southern Europe. Areas of high pressure follow in nearly the same paths; some of them pass from Athabasca southeast to N. 40°, thence east, and are lost in the Atlantic; others pass from the Pacific high area, at N. 35° or N. 30°, northeast to Utah, thence southeast over the south Atlantic States, and are lost in the Atlantic; still others pass from the central and western Atlantic northeastward into Europe, and are lost in the great area of high pressure that extends from southern Russia eastward over China.

In connection with the formation of cyclonic storms in northern and southern latitudes, attention must be called to the fact that frequently, and especially when it invades a continent, the circular cyclone degenerates into a long trough of low pressure, with cold northerly winds on one side and warm southerly winds on the other; in such cases the motions of the clouds show that above these two systems of winds there are corresponding outflowing or returning currents. Such troughs are stable when they extend east and west, as does the equatorial trough of low pressure, but unstable when they extend north and south. From such a trough trending north and south, or northeast and southwest, the circular cyclonic system may again develop, and the alteration from trough to cyclone, or *vice versa*, may in rare cases take place several times before the surplus energy of the storm is dissipated; the whole process is mechanically analogous to the alternate rectilinear and sinuous motions of water through tubes, as investigated by Osborne Reynolds, or to the various forms of wave motion, vortex motion, and steady motion of liquids. The difference between the cyclones of the tropics and the temperate latitudes is well stated in the following extract from "Elementary Meteorology," page 209, just published, by Prof. William M. Davis, of Harvard College:

As with tropical cyclones, the cyclones of our latitudes vary in intensity with the depression of the barometer at the center; and here as there the greater part of the depression is to be regarded as the effect of the centrifugal forces of the revolving winds; but the greater part of these forces in a tropical cyclone arises from the true centrifugal force of the wind's rotation around the storm center, and is only in a lesser proportion due to the deflecting force of the earth's rotation, while this relation is reversed in extra-tropical cyclones, where the deflecting force is greater than the true centrifugal force of the whirl, because of the higher latitude in which these storms occur. The central region of exceptionally low pressure and very steep gradients in tropical cyclones is relatively small, because a strong centrifugal force is produced only when the winds are whirling on a short radius; the low pressure area of our cyclones is much larger and the gradients have a tolerably strong value for some distance around the center, because the depression of the isobars depends rather on the latitude of occurrence than on the distance of the wind from the storm center; for this reason there is less concentration of violence close to the center, and the calm and clear central space or eye is seldom sharply developed, although it is not uncommon to discover a gradual weakening or failing of the winds, and sometimes even an imperfect breaking away of the clouds, as the central area passes over the observer. The form of tropical cyclones, as defined by their isobaric lines, is nearly circular. Our cyclones are, as a rule, less symmetrical, and their isobars are often elongated into an oval form. In the eastern United States the longer axis of the oval trends northeast, making a trough-like depression between the high pressure area over the tropical North Atlantic and the winter high pressure area of North America. In the North Atlantic the lowest pressure of the cyclone is commonly found south of the center of the outer isobaric ovals, thus giving steep gradients south of the center and weak gradients north of it; this is due to the occurrence of prevailing high pressures about the Azores and low pressures about Iceland. In the torrid zone, where the isobaric chart for January or July shows a relatively uniform distribution of pressure, these causes of irregularity are absent.

NORTH ATLANTIC STORMS.

The paths of the following areas of low pressure with revolving winds on the Atlantic Ocean during January, 1894, have been approximately traced on daily charts of simultaneous observations based on data received up to the 25th of February, through the co-operation of the Hydrographic Office, U. S. Navy, and the "New York Herald Weather Service." The western portions of these paths are shown on Chart I.

A. January 1 a low area was central about N. 47°, W. 47°; on the 2d it was at N. 52°, W. 38°, and on the 3d, N. 55°, W. 20°; it had been preceded by an area of high pressure on the east which was central over Norway and Sweden on the 2d, 3d, and 4th, the maximum being 31.0 in southern Norway on the 3d, at Greenwich noon; this high area then became a long oval or ridge as it moved southeastward into Russia and disappeared in southeast Russia, or the Caspian Sea, by joining the high pressure over Asia; meanwhile low area *A* advanced slowly northeastward and was joined by *B* on the 7th.

B. Low area No. II of the U. S. series, passed from Labrador on the 4th to the Atlantic north of Newfoundland on the 5th, and was, on the 6th, central at about N. 55°, W. 35°, while minor depressions were central in the English Channel and the western Mediterranean, and the whole region between N. 35° and N. 65°, and E. 5° and W. 60°, was below normal pressure. On the 7th the lowest pressure was central about N. 60°, W. 30°, and the extensive depression over the North Atlantic extended southeastward over the Mediterranean. By noon of the 8th pressure had generally risen over the Mediterranean, but had fallen in western Ireland, and the central depression had moved southerly until on the 9th, at noon, it was central at N. 50°, W. 25°, and by noon of the 10th at N. 55°, W. 20°, while pressure was still rising in eastern Russia; this had now become the center of the general depression of the North Atlantic which had the form of a long oval or trough on the 10th, but had closed up considerably by the 11th, while a special depression, *C*, was forming to the westward.

C. This appeared as a moderate depression on the 11th off the south Atlantic coast which, by the 12th, had been joined by a more important depression (U. S. series No. XI) from the Lake region, and by the 12th, noon, *C* was central at N. 44°, W. 64°; on the 13th at N. 47°, W. 57°; 14th, at N. 50°, W. 40°; 15th, at about N. 55°, W. 40°. By this time *B*, which was near N. 58°, W. 15° on the 13th, had moved northward beyond our reports, and the isobar of 29.5 extended from the coast of Newfoundland to North Cape, its southwestern end inclosed the area *C*, while at its northeastern end area *B* was filling up; 16th, noon, the center of *C* was at about N. 57°, W. 27°; 17th, noon, N. 60°, W. 10°; 18th, noon, N. 62°, W. 3°, after which this area moved nearly due east across southern Norway and Sweden and was, on the 20th, central in northern Russia.

D. On the 18th, 19th, and 20th the pressure was comparatively high over the North Atlantic from Africa westward over the United States, while an area of low pressure moved eastward from Labrador north of the limit of our marine reports; it was central, approximately, on the 18th in N. 57°, W. 35°, on the 19th, N. 58°, W. 20°, and on the 20th, N. 58°, W. 6°, being then over northern Scotland. European reports for later date have not been received at the Weather Bureau.

E. Meanwhile pressure continued steadily rising over the Atlantic, and was above 30.5 from Labrador to the Azores on the 21st; this area of high pressure moved slowly south and east and dominated the Atlantic between W. 10° and 60°, N. 20° and 40°, until the 28th; during the 29th, 30th, and 31st pressure rose to 30.79, or higher, between the Azores and the coast of Africa and Portugal. On the 28th, noon, the depres-

sion (U. S. series No. XVIII) that had passed over the Gulf of Saint Lawrence on the 25th and moved rapidly northeastward stretched as a long oval from Iceland to North Cape, while a following depression, *F*, was central at N. 50°, W. 50°, near the coast of Labrador and Newfoundland. The barometer was at this time quite low over all of Europe north of N. 50°, but high over the Atlantic and the United States south of N. 40°.

F. This area (U. S. series No. XIX) seems to have developed on the 26th off the coast of the south Atlantic States as the result of the flow of cold northwest winds over the warm waters of the Gulf Stream; it had had a previous existence as an unimportant whirl in the Gulf southwest of Florida, having apparently been started on the southeast side of the norther that swept over the western portion of the Gulf on the 24th and 25th. On the 27th the center was about N. 41°, W. 68°; 28th, N. 48°, W. 50°; 29th, it was north of our stations and reports, but on the 30th the center must have been, approximately, N. 63°, W. 8°.

G. On the 29th, a. m., a depression (U. S. series No. XXI) was east of the south Atlantic coast moving northward; this also had a previous existence as an unimportant depression in the Gulf, having originated on the southeast side of the northerly winds that prevailed in the western Gulf on the 28th; it passed inward over Chesapeake Bay on the 29th, and by the 30th, noon, it had united with a depression coming from the west and constituted a violent storm central a little east of Boston; 31st, noon, the center was near the southern coast of Newfoundland, while the preceding area, *F*, was central near the southern coast of Norway. At this time the isobar of 29.9 passed from St. Petersburg southwest to northern Spain and Portugal, thence northwest to N. 55°, W. 20°, thence southwest to N. 37°, W. 55° and 60°, thence northwest to Quebec, and the entire region north of this line was dominated by the low areas *F* in the east and *G* in the west.

It has often been pointed out that the formation of a norther in Texas and the Gulf of Mexico is due sometimes to the unusual coldness and density of the air that is flowing southward from the Mexican and United States Rocky Mountain plateau region, but that sometimes also it must be due to a slight deficit of pressure in regions far to the south, as a gradient of 0.01 of an inch per degree suffices to set the mobile atmosphere in rapid motion. In this connection the few reports that we have received from the southern portion of the Caribbean Sea are interesting, as they indicate that the pressure was about 0.1 of an inch, or 0.05 below the normal, in that region from January 15–22, but had risen to normal by the end of the month. A daily barometric report from the coasts of Venezuela, Central America, Guatemala, and Mexico would undoubtedly give a satisfactory basis for predicting the northers of the Gulf and the Caribbean Sea.

OCEAN ICE IN JANUARY.

The limits of the regions within which field ice or icebergs were reported for January, 1894, are shown on Chart I by crosses. The southernmost ice reported was in N. 44° 27′, W. 54° 15′, on the 18th, and the position of the easternmost ice was reported in N. 44° 48′, W. 46° 14′, on the 21st. More ice was reported during January, 1894, than in any corresponding month during the past 12 years. In 1893, on January 5, a large berg was noted in N. 47° 35′, W. 48° 34′; on the 8th a long, low berg was observed in N. 48° 10′, W. 47° 26′; on the 18th a berg was noted in N. 48°, W. 46°. In 1889 and 1892 no ice was reported. In 1891, on the 28th, 3 large icebergs were observed in N. 46° 30′, W. 52° 46′, and on the 31st patches of soft ice were encountered in N. 45° 50′, W. 59° 20′. In 1890 vast fields of ice and enormous icebergs were encountered over and near the Grand Banks, north of the forty-third parallel. In 1882 to 1888, inclusive, Arctic ice in small quantities was reported east of Newfoundland, but in no case was it sighted south of the forty-third parallel.

OCEAN FOG IN JANUARY.

The limits of fog belts west of the fortieth meridian, as reported by navigators, are shown on Chart I by dotted shading. Near the Banks of Newfoundland fog was reported on 9 dates; between the fifty-fifth and sixty-fifth meridians on 5 dates, and west of the sixty-fifth meridian on 4 dates. Compared with the corresponding month of the last six years the dates of occurrence of fog east of the fifty-fifth meridian numbered 2 more than the average; between the fifty-fifth and sixty-fifth meridians 4 less than the average; and west of the sixty-fifth meridian 2 less than the average.

TEMPERATURE OF THE AIR.

[*In degrees Fahrenheit.*]

The distribution of the monthly mean temperature of the air over the United States and Canada is shown by the dotted isotherms on Chart II; the lines are drawn over the higher irregular surface of the Rocky Mountain plateau, although the temperatures have not been reduced to sea level, and the isotherms, therefore, relate to the average surface of the country occupied by our observers; in mountainous regions such isotherms are controlled largely by the topography, and it is, therefore, not practicable to accurately present the temperature data in this manner unless a contour map on a large scale is published as a base chart.

NORMAL TEMPERATURE.

In the table of meteorological data from voluntary observers only the mean temperature is given for each station, but in the tables of climatological data for the regular stations of the Weather Bureau both the mean temperatures and the departures from the normal are given. In the latter table the stations are grouped by geographical districts, for each of which is given the average temperature and departure from the normal. The normal for any district or station may be found by adding the departures to the current average when the latter is below the normal and by subtracting when it is above.

MONTHLY MEAN TEMPERATURE.

For the regular stations of the Weather Bureau the monthly mean temperature is the simple mean of all the daily maxima and minima; for voluntary stations a variety of methods of computation is necessarily allowed, as shown by the notes appended to the table of meteorological data.

During January, 1894, the mean temperature was highest at Key West, Fla. (71.0), and was above 60 in the Florida Peninsula and extreme southeastern coast of Louisiana and the extreme southern portion of Texas. The temperature averaged 32 in a zone passing from Cape Cod, Mass., through Long Island Sound, northern New Jersey, central Pennsylvania, northern Ohio and Indiana, southern Michigan, central Illinois and Missouri, southern Kansas, northern Texas, New Mexico, Arizona, portions of Nevada, Oregon, and Washington. The lowest average temperatures in the United States were between zero and —4.7 in the Red River Valley between Minnesota and North Dakota. The isotherm of —10 passes through Manitoba and Saskatchewan.